

An LED-Based, Laboratory-Scale Solar Simulator for Advanced 3, 4, 5 & 6 Junction Space Photovoltaic Power Systems, Phase II

Completed Technology Project (2014 - 2016)



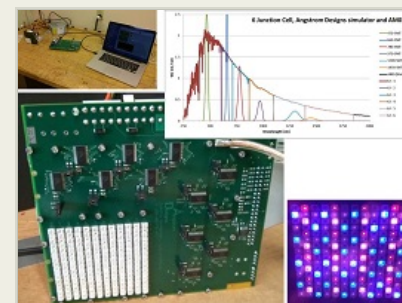
Project Introduction

As a result of significant technical effort, the Phase I was successful in delivering a solar simulator prototype that not only proved the initial concept but will significantly reduce future risk and increase our ability to deliver a fully-functional solar simulator in Phase II. The proposed innovation is an LED-based, laboratory-scale, solar simulator. The proposed innovation simulates AM0 response of single, dual, 3, 4, 5 and 6 junction solar cells by using an array of different wavelength LEDs in close proximity to the cell under test. The simulator is adjustable in spectral matching for selected wavelengths and Class A, the highest standard, for spatial uniformity and temporal stability. The solar simulator illuminates a square area 10 inches by 10 inches and includes optical sensors so that all metrics can be calibrated and validated automatically as needed. Solar simulation is critical for all solar cell testing, and current simulators will not work for coming 4, 5 and 6 junction technologies. Because the vast majority of NASA missions rely on solar cells, this is critical, enabling test technology for future solar cells. While accurate solar simulation is critical to all solar cell missions, it is particularly important to missions requiring large amounts of power, such as solar electric propulsion (SEP) missions. Beyond NASA's needs, other members of the aerospace community, including solar cell manufacturers, test labs and research institutions, have a critical need for this capability which presents excellent commercialization opportunities after the Phase II maturation of the technology.

Anticipated Benefits

Solar simulation of advanced 4, 5 and 6 junction cells will benefit all NASA missions, particularly high power missions such as solar electric propulsion (SEP). Solar simulation of advanced cells will enable industry standard practices on near-future solar cells. Additional applications include: - Advanced solar cells not currently available, including SBT6J, IMM with greater than 6 junctions and cells with quantum dots - Low intensity, low temperature (LILT) applications - LED-based large area pulsed solar simulation (LAPSS) - Class A AM0 spectral simulation using many more different LED wavelengths - A true AM0 simulator via LED augmentation of lamp-based sources

All of the potential NASA commercial applications also apply to non-NASA entities, including other government agencies, solar cell manufacturers, aerospace prime contractors, aerospace subcontractors and research institutions. Some of these applications include: - 4" or 6" round illumination area LED-based solar simulators for measuring a single cell, or wafer - 2" or 3" round illumination area LED-based solar simulator for measuring test cells and early research efforts into advanced photovoltaics - Custom testing of advanced cells, including sensitivity studies to selectively current-starved



An LED-Based, Laboratory-Scale Solar Simulator for Advanced 3, 4, 5 & 6 Junction Space Photovoltaic Power Systems, Phase II Briefing Chart Image

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junction testing, selectively current-flooded junction testing, reemission/reabsorption of photons by neighboring junctions and many other tests as researchers see opportunity. - AC modulation of LEDs enables standard AC modulation technique, such as noise reduction through AC modulation, cell capacitance measurements and non-contact I/V measurement of cells before frontside ohmic contacts are added. - Terrestrial technologies, up to 6 junctions, could greatly benefit from the spectral control and flexibility of this instrument. All benefits listed above could apply to terrestrial cells as well, with the greatest benefit for multijunction cells. - Some past partners in other projects have already expressed interest in investing in a potential Phase II-E for commercialization and scale-up into the market.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Glenn Research Center(GRC)	Lead Organization	NASA Center	Cleveland, Ohio
Angstrom Designs, Inc.	Supporting Organization	Industry	Santa Barbara, California
University of California-Santa Barbara(UCSB)	Supporting Organization	Academia	Santa Barbara, California

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Glenn Research Center (GRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

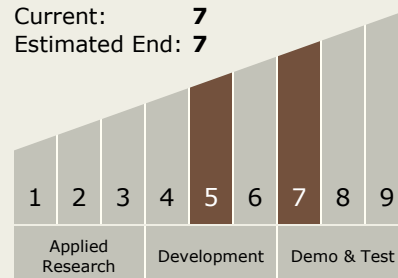
Carlos Torrez

Principal Investigator:

Casey P Hare

Technology Maturity (TRL)

Start: 5
Current: 7
Estimated End: 7



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Primary U.S. Work Locations

California

Project Transitions

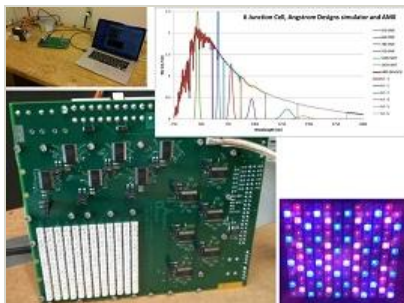


September 2014: Project Start



September 2016: Closed out

Images



Briefing Chart Image

An LED-Based, Laboratory-Scale Solar Simulator for Advanced 3, 4, 5 & 6 Junction Space Photovoltaic Power Systems, Phase II Briefing Chart Image
(<https://techport.nasa.gov/image/30291>)

Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
 - └ TX03.1 Power Generation and Energy Conversion
 - └ TX03.1.1 Photovoltaic